GENERAL ELECTRIC

GEH-1066B

General Installation and Operation of Kenotron Tubes

Installation

MECHANICAL

The handling of a kenotron in transportation and storage requires great care since the tube may be permanently damaged if subjected to shock. Each tube is suspended within its shipping carton so that it will not come in contact with the sides of the carton during shipment. The tube should be stored in the carton and should be protected from moisture and extreme temperature changes. Furthermore, while the tube is being handled it should be kept in a vertical position with the cathode end down. Under no circumstances should crated tubes be piled on top of one another.

The kenotron should be installed in a vertical position with the cathode base down.

In installations where a nonrigid anode connection is used, reasonable flexibility must be provided to prevent placing a strain on the cathode base. Since the bulb becomes hot during continuous operation, it should not come in contact with any metallic body, nor be subjected to the drops or spray of any liquid.

The accumulation of dust and metallic particles on the outer surface of the glass walls will increase the leakage over this surface. As this may result in tube failure from arc-over, periodic cleaning of these surfaces should be maintained.

When a kenotron is operated at voltages above 75 kv peak inverse, harmful x-rays may be generated. Adequate protection against these x-rays should be provided.

COOLING

Free circulation of cool air around the glass bulb should be maintained. High-temperature air from other apparatus should be prevented from circulating around the tubes. If desired the tubes may be immersed in a tank of oil with the transformers.

ELECTRICAL

Filament power should be supplied from a filament lighting transformer insulated for the proper voltage. This transformer should be provided with a secondary midtap for the plate circuit return lead. The filament excitation supply must be provided with suitable resistors or other regulating devices to apply the power to the filament gradually and to adjust it accurately during operation. The filament voltage should be measured directly at the filament terminals.

The high initial rush of current through the filament when the switch is first closed should be limited by the use of some form of filament starter. The proper use of the filament regulating devices will prevent this initial rush of current from destroying the filament. In any case, the current through the filament should never, even instantaneously, exceed twice the *rated value.

When the apparatus in which the tube is used is to be idle for periods not exceeding two hours, voltage should be maintained on the filament. However, if desired, provision may be made to reduce the filament voltage to approximately 80 per cent of the *rated value during "standbys." Where stand-by periods exceed two hours the filament voltage may be removed.

The plate circuit should be provided with a time-delay relay which will prevent application of plate voltage until the filament has reached normal operating temperature.

Automatic protective devices should be installed to prevent over-plate-voltage, over-plate-current, or under-filament-voltage conditions.

In the case of multi-phase installations, the plate transformer is usually designed for rectifier use. In the case of a double Y rectifier, the use of an inter-phase transformer is recommended. The cathode base should not be connected to ground or to any other part of the circuit.

The installation of all wires and connections should be made so that they do not lie on or close to the glass of the kenotron. An air space of approximately the length of the tube should be main-

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*Note: The ratings and characteristics of a particular tube are given under Technical Information on the Description and Rating Sheet for that tube.

FIG.1

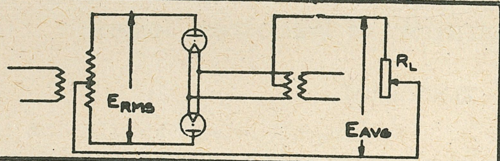

FIG.4

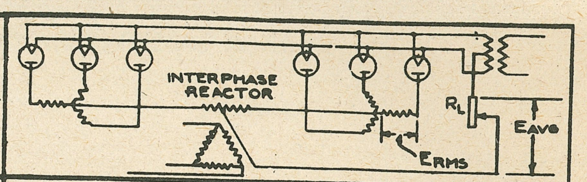

FIG.2

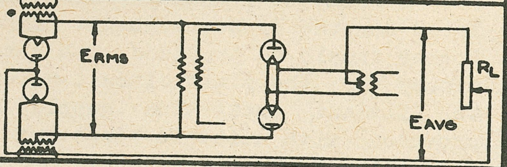

FIG.5

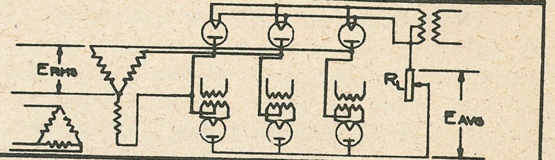

FIG.3

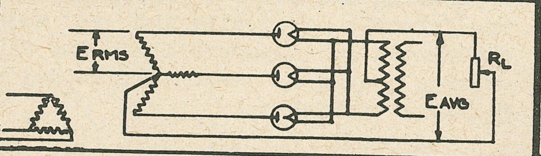

FIG.6

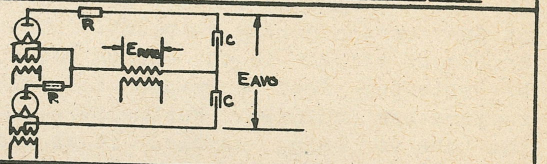

Fig	Circuit	E average	E inverse	I average
1	Single-phase, Full-wave	0.318 Emax 0.450 Erms	Emax 3.14 Eavg	0.636 Imax
2	Single-phase, Full-wave	0.636 Emax 0.900 Erms	Emax 1.57 Eavg	0.636 Imax
3	Three-phase, Half-wave	0.827 Emax 1.170 Erms	$\sqrt{3}$ Emax 2.09 Eavg	0.827 Imax
4	Three-phase, Double-Y Parallel	0.827 Emax 1.170 Erms	1.732 Emax 2.09 Eavg	1.91 Imax
5	Three-phase, Full-wave	1.65 Emax 2.34 Erms	$\sqrt{3}$ Emax 1.05 Eavg	0.955 Imax
6	Voltage Doubler	2.83 Erms No Load Conditions	Eavg No Load Conditions	

Note for Fig 6:

Output voltage depends on load and circuit regulation. The circuit must be designed so that the tube ratings are not exceeded. Particularly, values of C and R must be chosen to limit charging current so that peak current rating of tube will not be exceeded.

tained between the bulb and any metallic body during operation. Otherwise, corona discharge may develop and result in puncture of the glass bulb.

Operation

Ordinary care in handling and provision for the necessary operating conditions peculiar to the kenotron will minimize accidental damage to the tube.

The maximum values given in the *rating of kenotrons are the values beyond which it is unsafe to operate, if the maximum life and performance are desired. For example, the maximum operating plate voltage can be obtained from the Technical Information and the amount of voltage fluctuation, due to line, load, and manufacturing variation in the apparatus must be determined or estimated. An average value of plate voltage must be used which, under normal operating variations, does not exceed the maximum rated value.

With regard to power, the ratings given on the Technical Information prescribe two limiting operating conditions. The first is a maximum peak inverse voltage which should not exceed a certain safe value determined by the insulation between electrodes of the tube. The maximum peak inverse voltage is the highest voltage that the tube will insulate on the half cycle when no current is passing through the tube. As any and all of the following factors - line surges, circuit capacitance, wave form distortion, and the maximum peak voltage of the applied alternating voltage - may increase this inverse voltage to a value higher than the rated maximum peak voltage, the kenotron should never be used at the maximum rated voltages unless measurements, either by oscillograph or sphere gap, have indicated that at no time does the peak voltage across the tube exceed this value.

The second limiting value is the power dissipation of the plate which is determined by the d-c load current almost regardless of the voltage across the load. The maximum peak plate current is the greatest instantaneous current that may be drawn from a kenotron on the half cycle during which the plate of the tube is positive. As the design of the circuit, especially the amount of capacitance in the circuit, is a major factor in determining the amount of current available in a given rectifier, oscillograph measurements of this current should be made if any doubt exists as to the magnitude. If the kenotron is to be operated at full *peak current rating, it will be necessary to maintain exactly the rated filament voltage. If the peak current to be drawn is less than the full rated value, the allowable filament voltage regulation increases as the value of the peak current decreases.

The following tabulation shows the reduction of the maximum peak current with reduced filament voltage:

Filament Voltage % of Rated	Maximum Peak Current % of Rated
100	100
95	65
90	40
85	25
80	10

Excessive anode temperature is an indication of abnormal voltage drop in the tube and is usually caused by low filament temperature. Filament voltage greater than the rated value, while increasing the maximum peak current available, will result in decreased tube life.

The regulation of the filament supply voltage should be such that the minimum filament voltage will not be less than that recommended in the tabulation for the peak current demand.

The filament should be operated at constant voltage rather than at constant current and should always be allowed to reach normal operating temperature before the plate voltage is applied.

Six basic circuits in which the kenotron may be used are shown schematically on Fig. 1. The values given are ideal conditions which usually cannot be obtained in actual installations because of poor regulation and other abnormal supply line conditions. Therefore, these factors must be considered and subtracted from the supply voltage to the tubes in order that the maximum voltage rating is not exceeded.

In parallel operation the filaments of all tubes must be supplied from a common source and the voltage of this source must be adjusted to the rated value of the individual tube when all tubes are lighted.

In series circuits, separate filament transformers must be provided. Also provision must be made for equalizing the voltage drop of each tube in the series.

When any kenotron, except the FP-85, is first placed in operation the following procedure should be observed. The tube should be operated without plate voltage for five minutes at rated filament voltage. After this initial preheating schedule, the plate voltage can be applied. Start with not more than one-half the usual operating voltage and then carefully increase it in steps over a period of approximately 15 minutes to the desired value. The tube should then be operated under the normal load conditions for a period of approximately 15 minutes or more. If the plate voltage is varied by taps on the primary, the plate-circuit relay should be open when the taps are changed in order to avoid dangerous surges. It is recommended that every three months spare tubes be given the preheating and initial operation schedule as discussed above. This will insure that only good tubes are carried in stock.

GENERAL ELECTRIC
SCHENECTADY, N.Y.

7-42 (4M)
Filing No. 8850

Supersedes GEH-1066A

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ELECTRONICS DEPARTMENT

GENERAL ELECTRIC

Kenotron KC-4--Description and Rating

The KC-4 is a kenotron for use as a high-voltage rectifier.

TECHNICAL INFORMATION

These data are for reference only. For design information see the specifications.

GENERAL CHARACTERISTICS

Electrical

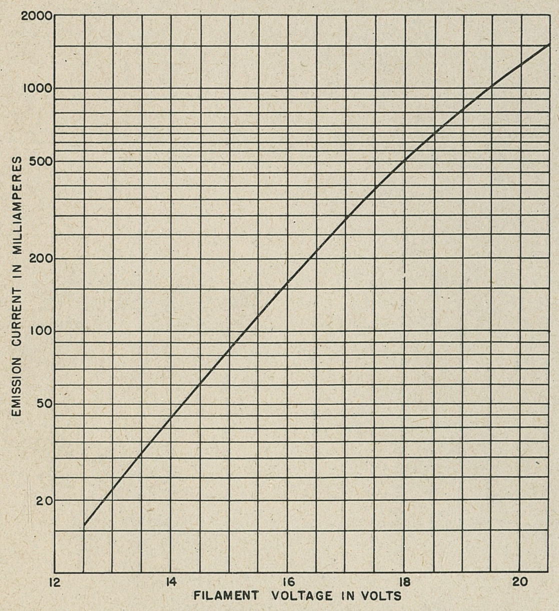
Cathode - Filamentary		
Filament Voltage	20	Volts
Current, approximate	24.5	Amperes

Mechanical

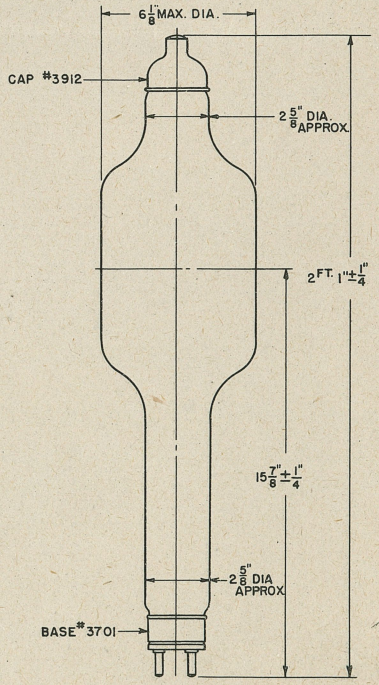
Type of Cooling - Convection		
Maximum Ambient Temperature	60	C
Net Weight, approximate	3	Pounds
Shipping Weight, approximate	9	Pounds
Installation and Operation - ET-H14		

MAXIMUM RATINGS

Peak Inverse Voltage	150,000	Volts
Peak Plate Current	750	Milliamperes
Plate Dissipation	750	Watts



Emission Characteristic
KC-4 Kenotron
K-6917415 8-25-44



Outline KC-4 Kenotron
K-2636627 7-1-44

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y.

12-44 (15M)
Filing No. 8850

Supersedes ET-T73

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